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PRELIMINARY OBSERVATION ON THE DESTRUCTIVE BURROWING OF SHALE.

BY O. C. CHARLTON, OTTAWA.

The shale rocks exhibited were obtained but a few hours before the meeting of the Academy. They are completely honeycombed by some burrowing animal not yet examined. The tubular cavities are about one-tenth inch in diameter, and, in some of the rocks, so close together that they are too fragile to admit of handling, even gently, without crumbling. Living animals are found only in rocks covered by water. Large numbers of the loose rocks are being thus destroyed.

PERIODICITY IN PLANTS.

BY B. B. SMYTH, TOPEKA.

I.

That plants have a regular time each year for leafing, blooming, and fruiting, is a fact well known. From the first blooming of the white elm early in March, or even in February, to the final blooming of the sow thistle (Sonchus asper) in November, there is a constant succession of bloom, and each and every plant passes through the successive steps of its development in its appropriate season. There may be a difference in early spring of as much as thirty days in the first blooming of certain plants, according to the advancement of the season. As the summer progresses the differences of time of first blooming in different years decrease, until in midsummer it is rare to find a difference so great as ten days in the different years; and later in the fall it must be an unusual year indeed that makes even so much of a difference as ten days to occur in the first blooming of a plant at any one place. Hence, in general terms, a late spring, an early fall, and a short growing season, hastens the growth and development of a plant; and a long season retards the maturity and increases the growth of a plant.

But, generally, plants are so prompt about their motions, such as the opening of leaves and flowers, that an average day may be taken for the first blooming of any individual species, and that particular species will be ordinarily found in bloom within three days from the appointed time, but oftener on the particular day. This refers especially to particular plants in a certain location.

Not only does each species have its set time for performing its different functions, but in any species each different variety has its own time, often differing widely, as in the ripening of apples. Further than that, each individual tree has its own certain time for opening its leaves, blooming, and ripening its fruit, from which it seldom or never varies a day in years having equal temperature during the days and months preceding the looked-for phenomena. For instance: a large male cottonwood tree in Mr. F. W. Giles's park at the northeast corner of the State yard comes into bloom usually about April 12th, and in four days it has shed all its blossoms. Two days later, April 14th, a large male cottonwood tree in the State yard, between the east wing and the arsenal, opens its blossoms. On the 15th it is fairly magnificent in its wealth of bloom, and two days later it has shed every blossom. Five days later a large male cottonwood in Dr. Gibson's yard, 300 yards distant to the southwest, expands its flowers and for two days is a most beautiful object, and then promptly sheds its limp aments with their depleted anthers. Between the extremes mentioned, or say between April 10th and April 25th, every cottonwood tree, male and female, in and around Topeka, has fulfilled its estival mission and started in untold numbers the germs of future cottonwood trees.

II.

Not wishing to dwell on the annual periodicity of development in plants, features that are so well known, I turn now to the second division of this subject, and speak of certain daily motions in plants, showing that they are cognizant of light and darkness, as of heat and cold. In addition to that, I will attempt to show that plants are sensitive to varying conditions of the atmosphere, to touch, and even to contiguity of objects.

Plants can feel, of course; but do they actually see?

How often have we seen potato-sprouts, turnip-tops, and other plants in the cellar, stretching out as far as possible and leaning over in an attempt to reach the window where the only feeble rays of light enter the cellar. In the same way you have all seen, in the open air, the leaves turn their faces up to the light, and when they grow on the side of a house, turn sidewise to the light; and if under a roof, will still turn their faces toward the brightest light. And the tendrils, those modified forms of leaves, always turn away from the light.

We are not aware that we are cognizant of light by any organ except our eyes, and we call that seeing. The plant is cognizant of light in its leaves, in all their modifications. Is it not, at least, analogous to seeing? Is it heresy to say that, so far as light is concerned, plants can see?

Everybody knows that the morning glory opens in the early morning, and that the evening primrose opens about sunset; but not everyone knows that each different species of flower opens regularly each day at its own appointed hour. For instance, our common morning glory (Ipomœa purpurea) opens before 5 o'clock, and the blue morning glory (Ipomœa hederacea) opens after 5, or about an hour later. Similarly, our wild bush morning glory of the prairies (Ipomœa leptophylla), the immense roots of which many of our western Kansas farmers have encountered with the plow, opens at 4 o'clock in the morning, very regularly; and two other species of morning glory, both with small white flowers, open still earlier. One of these (Convolvulus arvensis) has small, arrow-shaped leaves, and creeps on the ground; the other (Ipomœa lacunosa) has medium-sized, heart-shaped leaves, with a small lobe on each side, and climbs. Both of these have tuberous roots, and hence are, in a sense, perennial. The common white morning glory of our hedges and thickets (Convolvulus sepium) opens very early in the morning, perhaps soon after midnight; and yet another, the common white creeper (Convolvulus spithamæus), opens several hours before midnight, or late in the evening; hence is called the evening beauty. Several other species of Ipomœa, commonly called moon-flowers, open at early evening and close at daylight.

One remarkable thing about this family of morning glories remains to be told: all the night-blooming species are pure white, and all the morning-blooming kinds are colored. True, there are white varieties of many of the day-blooming kinds, as a white variety of the purple morning glory, a white variety of the blue morning glory, a white variety of the red flowered cypress vine, etc.; but in all of these there are traces in the center, or along the ribs of the corolla, of the original color, and none of them is pure white.

The evening primroses, too, have just as great variation in their times of blooming. Thus, the common great-flowered evening primrose (Œnothera grandiflora) opens very promptly at 7 o'clock in the evening, and wilts about 7 o'clock next morning. A still larger and more remarkable flower (Œnothera missouriensis), not found in gardens, but on the rocky hills of eastern Kansas, opens more promptly at 7 o'clock, or just about sunset. A smaller-flowered species (Œ. sinuata) opens earlier, or about 6 o'clock. The handsome white evening primrose, so common in the streets of Topeka in the summer-time, and that keeps its flowers open so nicely all day, I have not yet learned when they open, as I have never yet had the pleasure of seeing one unfold its petals. But there are numerous species that open during the day, and it is to be noted that each species has its own regular time for opening.

The gauras, belonging to the same family, are just as regular in their habits. Gaura coccinea, the scarlet gaura, opens at 6 o'clock in the evening, is a pure white all night, and changes to a beautiful rose-color at daylight; which color deepens slightly until early afternoon, when the flower wilts. Gaura biennis, a tall weed with long, slender, far-reaching branches, opens its pure white flowers an hour after dark, from 8 to 9 in the evening, and remains open until about 10 o'clock next day, still very white, but changing slightly to rose-color before fading. Gaura parviflora, known by its soft, silky leaves, opens at the same hour, closes a little earlier, and changes strongly to rose-color before fading.

How many have noticed our common jimson (Datura stramonium) opening from 5 to 6 o'clock every evening? Just as regularly it closes early in the morning. Several of our cultivated jimsons (Datura metel, etc.), with their beautiful large white flowers and delightful fragrance, open very promptly at sunset, and close just as regularly in early morning.

Another group of flowers noted for their great regularity is our wild four-o'clocks. The common kind, with the large, heart-shaped leaves (Oxybaphus nyctagineus), opens its flowers very regularly every afternoon at 4 o'clock, even much more regularly than the four-o'clock of the gardens. Another (O. angustifolius), with a deeply-lobed white calyx, opens at 5 o'clock, or from that to 6. All the species of Oxybaphus open late in the afternoon. Abronia fragrans, a handsome sand-hill plant of the same order, opens at 6 in the evening.

Another plant of an order allied to the morning glories, and with a strong tendency to periodicity, is Heliotropium convolvulaceum, which is common on the sandy plains of southwestern Kansas, and spreads its sweet-scented white trumpet flowers in early twilight.

Several plants of an order allied to the evening primroses, and somewhat to the poppies, are periodic in the time of opening their flowers. Mentzelia oligosperma opens early in the morning and closes about one o'clock in the afternoon. Mentzelia nuda, with remarkably large, creamy-white flowers, opens at three o'clock in the afternoon, with its buds all turned toward the southwestern sky, so that the flowers open directly in the face of the sun, just as the daily temperature has begun to decline. Mentzelia ornata, with still larger, yellowish-white flowers, opens an hour or two later. Both of these close early next morning, and remain asleep all day to reopen in the afternoon.

The regularity of opening of many members of the chickweed and purslane families is well known, the former flowers opening in the evening, the latter in the morning. Somewhat allied to this last is the cactus family, the regularity of blooming in certain members of which is well known.

These observations, with others unmentioned, may be tabulated into what may be called

A FLORAL CLOCK FOR KANSAS.

2 to 3 A. M....Convolvulus sepium; closes next evening.
3 A. M.........Ipomœa lacunosa; closes about 2 P. M.

3 to 4 A. M.... Œnothera speciosa; lasts all next day.
4 A. M........ Ipomœa leptophylla; closes at noon.
Convolvulus arvensis; closes at 10 A. M.
4 to 5 A. M.... Ipomœa purpurea; closes about noon, except when the weather is cool and cloudy.
5 A. M........ Ipomœa hederacea; does just about the same.
Mentzelia oligantha; closes at 1 P. M.
5 to 6 A. M.... Commelyna virginica; closes in heat of day.
Tradescantia virginica; closes after noon.
Evolvulus argenteus; closes at 4 P. M.
6 A. M........ Castalia odorata; closes at 3 P. M. to reopen.
Pyrrhopappus scaposus; closes at 6 P. M. to reopen; closes also in continued rain or dense cloudiness.
Sonchus oleracea; withers at noon.
7 A. M........ Callirrhoe involucrata; closes 6 to 7 P. M. to reopen next day.
Troximon cuspidatum; closes at night to reopen.
Taraxacum dens-leonis; closes at dark to reopen, except in rainy weather, when it may be closed in daytime and open at night.
7 to 8 A. M.... Oxalis stricta; closes at noon for good.
Oxalis violacea; closes at noon to reopen?
8 A. M........ Linum rigidum; falls off at 4 P. M.
8 to 9 A. M.... Specularia leptocarpa; closes permanently at 2 P. M.
9 A. M........ Portulaca pilosa; closes at 1 P. M.; does not reopen.
Portulaca grandiflora; closes at 2 P. M. to reopen.
Portulaca oleracea; wilts after noon.
10 A. M....... Mesembryanthemum spectabile; closes at 2 P. M. to reopen for several days.
11 A. M....... Talinum teretifolium; closes in afternoon.
Mesembryanthemum crystallinum; closes to reopen.
12 M......... Hibiscus trionum; closes again at 2 P. M.
1 P. M........ Silene antirrhina; lasts until night.
2 P. M........ Mamillaria vivipara; closes at 5 P. M. to reopen next day.
Mamillaria missouriensis; does the same.
3 P. M........ Mentzelia nuda; closes at daylight to reopen.
4 P. M........ Mirabilis jalapa.
Oxybaphus nyctagineus; closes next day.
4 to 5 P. M.... Oxybaphus angustifolius; closes 5 A. M. next day.
5 P. M........ Mentzelia ornata; closes in the morning to reopen.
5 to 6 P. M.... Silene noctiflora; wilts next morning.
Datura stramonium; wilts next morning.
6 P. M......... Œnothera triloba; lasts nearly all next day.
Abronia fragrans; wilts early in the morning.
Gaura coccinea; fades next day.
6 to 7 P. M..... Heliotropium convolvulaceum; wilts next day.
Œnothera sinuata; wilts next day.
7 P. M......... Datura metel; closes and wilts next morning.
Œnothera missouriensis; wilts at sunrise.
Œnothera grandiflora; opens very promptly; wilts at 7 A. M. next day.
8 P. M......... Gaura biennis; wilts about 10 A. M. next day.
Gaura parviflora; does the same, pretty much.
9 P. M......... Ipomœa bona-nox; closes early next forenoon.

10 P. M........Phyllocactus phyllanthus; closes before daylight to reopen for one or two times.
10 to 11 P. M...Cereus grandiflorus; closes before morning.
11 P. M........Cereus speciosissimus; wilts at 2 A. M.

The above clock is the result of many years' observation; yet it is still subject to some correction. Most of the plants in the above list are native in Kansas; a few are introduced or cultivated, as Taraxacum dens-leonis, Portulaca grandiflora, the mesembryanthemums, Mirabilis Jalapa, Datura metel, Ipomœa bona-nox, and the last three cacti.

In cases where a flower reopens for several successive days, it will be seen that the stigmas and stamens are ready for action on different days.

An idea has already been touched upon that is foreign to the subject of this paper, namely, that night-blooming plants are always white or yellow; and on the other hand, all blue, purple, and red flowers are day-blooming — not that all yellow or white flowers are night-blooming, or that all day-blooming flowers are blue, purple, or red.

Why are night-blooming flowers white or yellow? Isn't the reason for this very clear? They can be distinctly seen for long distances by night-flying insects.

It may be seen that many plants have preferences among the insects. For instance: Œnothera missouriensis admits the cecropia moth only; no other moth has a sucker long enough to reach the nectar, which is at a depth of nearly six inches; and no other moth is so well adapted to perform the important office of fertilization. Œnorthera grandiflora admits both cecropia and polyphemus moths; other species of œnothera are not so particular. Again, the red clover, with its large stores of honey, does not admit the common honey-bee; so that that insect must confine its labors to white clover or elsewhere. The red clover prefers the bumble-bee; and the form of that insect is found to be best adapted to fertilization of that plant.

So it may be found that every kind of flower has one or more particular kinds of insect best adapted to it, and opens at the time of day only when such insects are on the wing.

One curious feature in this connection may be mentioned: The common prickly pear (Opuntia missouriensis) conceals no nectar; but its stamens are not merely sensitive — they are irritable to a high degree; and when an insect, attracted by the sight and odor, alights upon the flower, the stamens immediately spring in upon him from all around and cover him with pollen. Taken by surprise, he immediately flies away, perhaps to another flower of the same kind, to be treated in the same manner; but, in all probability, the prominent style of the prickly pear is ready to receive the pollen, and quickly catches some of that which the insect has brought with him from a neighbor.

III.

I now come to the third part of my paper, a certain series of motions in leaves, tendrils, suckers, etc., depending upon the time of day or the requirements of the plant. It goes without saying that the roots of a plant shoot downward and the stem turns upward. That is, they do that as far as circumstances will admit. If a plant start in a perpendicular bank the roots run into the bank and downward; the stem outward and upward.

If the plant be a twining vine, as soon as it has attained sufficient length, the terminal bud commences to move around in a circle, the hop around to the right, looking outward from the center, the morning glory to the left. As the vine grows it increases gradually the circle in which it moves, until finally it touches something or drops to the ground from exhaustion or its own weight. As soon as it has touched something, it makes a short, quick turn and wraps around it, though it may be only another similar vine unable to support it.

These motions result always in each plant growing in the place that is best adapted to its growth. Why, for instance, does the Ampelopsis virginica climb a tree, or a stone or brick wall in preference to a bush or a haystack? The tendrils of the Ampelopsis at first, like the tendrils of a grape-vine, seek the dark side of the vine, and finding a solid vertical support that they cannot grasp, accommodate themselves to the conditions and flatten the tips, forming sucking disks that take firm hold of the tree or the face of the brick or stone. Here the vine thrives best; and all that portion of the vine leading to the tree, which may be fifty feet from where the Ampelopsis seed germinated, dies, giving the vine the appearance of having germinated at the base of the tree or wall.

A very large wistaria was climbing a stone house, partly by trellis, partly by strings. An apple tree stood near, whose branches reached close to the wistaria vine. Thinking to have part of the wistaria climb the apple tree, I separated some of the vines and laid them over on the branches of the apple tree. But they refused. In three days all the vines had turned toward the house, and some of them had reached back to the main vine by the house. Several attempts of the same kind resulted in failure. The vines came back from the apple tree and climbed the other vines by the house at last. The young vines, clinging close to the house, reached far from the supporting trellis, and climbed over the eaves, clinging close by some means, but so effectually that the storms of winter or summer fail to dislodge them.

A climbing ivy, in order to hold to a tree, sends out numerous rootlets from any place along the dark side of the vine; and the ampelopsis has its sucker-like tendrils at the joints; but how does the wistaria manage to cling? In this case branches act as tendrils, partly. They bend around projections, and, stiffening with age, hold the vine. Temporarily, leaves do the same thing until the branches have grown.

Leaves, like flowers, often have certain times of the day for opening and closing. Most noticeable among these are certain species of Euphorbia, notably E. serpyllifolia, E. glyptosperma, E. maculata, E. humistrata, and E. Preslii; also the dogbane Apocynum androsæmifolium. These plants all have opposite leaves, and in the case of the euphorbias, oblique, or lefts and rights; and as soon as the dew begins to fall, they fold together in pairs, as a child folds his hands to pray, and, with the light-colored under-side out, remain thus all night.

Many of the leguminosæ, notably cassia, desmanthus, and desmodium, fold their leaflets at night. These leaflets are jointed to the midrib, and the midrib to the branch, by noticeable articulations that allow a motion of both leaflet and leaf. Daylight opens the leaflets and raises the leaf. Thus, leaves are said to be asleep when they are closed for the night.

But not all plants fold their leaves with the faces together, as do the plants of the pea family. The sorrel, for example (Oxalis stricta and O. violacea), folds its leaflets back to back, and the whole leaf droops from its junction with the petiole. Again, Abutilon avicennæ, with its very large, velvety leaves, droops straight down from the junction of the blade with the petiole; the petiole remaining in its normal position, and the leaf hanging face outward.

Everyone, probably, has seen the sunflower turn its leaves eastward to the morning sun, and westward in the evening. Many other plants do precisely the same thing, among which may be noted beans, ragweed, rosinweed, marigold, and many other plants of various families. One notable plant of this character is a certain variety of Hosackia Purshiana, whose leaves turn eastward in the morning and westward in the afternoon. To facilitate this, all the branches and leaves grow toward the north and south, so that the leaves simply have to turn over. In the case of the Silphium laciniatum, where the two surfaces of the leaf are just about alike, the leaves do not turn one face upward, but stand vertical, with one face to the east and the other to the west, and with the edges north and south. Thus, the leaves, which are rigid, get the benefit of all the sunlight; and the plant only grows on an open prairie, in a sunshiny country.

AN IMPROVED FIRE-SCREEN; AND NOTES ON THE THERMAL RESISTANCE OF FIRE-SCREENS.

BY T. H. DINSMORE, EMPORIA.

[*Abstract.*]

This fire-guard is so constructed as to secure neatness of design and unusual security from fire. The subject of thermal resistance of fire-screens is reviewed, and it is shown that resistance varies directly with the distance frôm the fire, and inversely with the meshes of the guard.

METHODS OF COLLECTING, CLEANING AND MOUNTING DIATOMS.

BY GERTRUDE CROTTY, LAWRENCE.

The diatomaceæ, called by the writers of the early part of this century bacillariaceæ, are now generally considered to be unicellular microscopical algeæ. This classification is based upon their usual method of reproduction—that by fission or division. Several eminent scientists, however, as Dr. Farlow, of Harvard College, yet hold that, on account of their freedom of motion, they ought to be placed in the animal kingdom.

The first forms of this microscopical plant were discovered at the close of the last century by the celebrated Danish micrographer, O. F. Müller. There have now been described over ten thousand varieties. This number is enormous, considering the fact that American forms have been little studied. With the exception of the late Prof. H. L. Smith, America has not produced what Dr. Henri Van Heurck means by his term "diatomophile." Owing to the fact that allowance has not been made for degeneration in size of any variety, due to division, it is very probable that this number has been unnecessarily increased.

Each individual diatom is incased within a silicious covering. This covering is composed of two halves, or valves, one fitting over the other as does a lid over a box. The point of union, the point where these two valves overlap one another, is termed the connective zone or girdle. These valves are marked by rows of punctures, or stria, except at the center, and frequently each end. The unstriated points are the nodules. These nodules are united by a line, the raphe, or median line. Each cell or plant contains a nucleus and nucliolus, protoplasm and a greenish-brown substance—the endochrome; likewise, several oily globules. Each plant is also covered by a mucilaginous coating, which may be detected by